

The 3<sup>rd</sup> International Geography Symposium - GEOMED2013

## Land degradation and natural environment in the western Anatolia

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**Abstract**

The study area is located in the lower part of the Aegean region which is part of the Western Anatolia. The area has appropriate natural environmental conditions (such as climate, topography, soil, water, natural harbor, transportation facilities, etc.). Due to the suitable conditions, there are intensive population and variety economic activities. The settlement started in 2,000 BC with Lydian, Ionians (Ephesus, Miletus, Pergamum, etc.) and continued with Roman, Seljuk and Ottomans. These can be seen in the several places in the research area. Due to the suitable land for agriculture, water sources and forest land, transportation facilities (land and sea transport availability), western Anatolia has been seen continuously under the human pressure. Depending on the increased requirements, settlement areas in the agricultural lands and agricultural activities in the forest land have developed.

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Selection and peer-review under responsibility of the Organizing Committee of GEOMED2013.

**Keywords:** Land degradation; Western Anatolia; forest destruction; mis-land use; remote sensing.

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**1. Introduction**

The study area is located in the western part of Anatolia, between the southern slopes of Kaz Mountain in the north and Köyceğiz district in the south. It covers the Aegean coast in the west and the western part of the inner west of Anatolian (Fig. 1).

The Ege sub-region occupies 3700 km<sup>2</sup> consisting of 47 % of Aegean geographical region and about 5 % of Anatolian peninsula.

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The study area has typical horst-grabens topography. Horsts correspond to the mountainous areas; grabens constitute the lowlands on which plains occur.

Mediterranean climatic conditions characterized as mild and rainy winters, hot and dry summers prevail in the region.

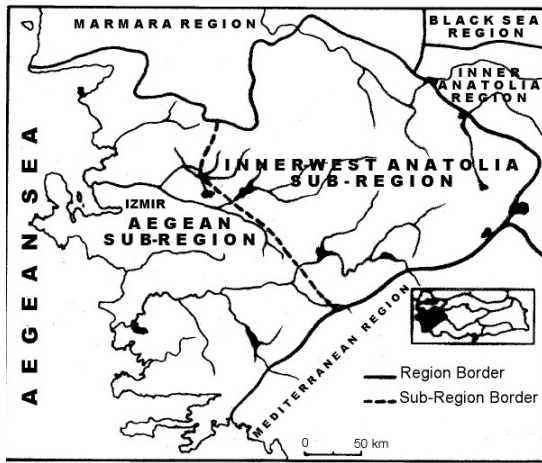


Fig. 1. Aegean Region of Turkey

Topographic properties (exposure, elevation, direction of mountains), parent material and drainage lead to the diversification of the natural environment (Çukur, 2001).

Settlement areas have been developed depending on the increased demand, and agricultural activities shifted to the forest lands (Çukur et al., 2003).

Detection of the most important examples of degradation is as follows: settlement/buildings occur on the farm land; agricultural activities and overgrazing shifted in the forest land and upper parts. As a result of all of these, forests lands replaced with shrubs/maquis formation and grassland in the study area. The goal of this study is to determine the land-use change, size of these areas and miss-land use examples in the western Anatolia.

## 2. Material and Method

Landsat (p179 r034, p180 r033, p180 r034, p181 r033, p181 r034 seven bands) images 1990 and 2055 were used and analysed (<ftp://ftp.glcf.umd.edu/glcf/Landsat/WRS2/p179/r034/15/05/2013>). Supervised and unsupervised classification analysis method by means of GIS and RS (Arc GIS and Erdas) software was used. In the first step, 50 different class types by means of unsupervised classification were made. And second step “recode method” was used in order to decrease land use types from 50 to 9 classes.

## 3. Main geographical properties of study area

Horst-graben system which was formed by the vertical tectonic movements that occurred between upper Tertiary and lower Quaternary occur in the western part of the region. Low areas or corridors correspond to the “grabens” and the mountain ranges forms the horsts. The horsts ranging from north to the south are Kaz, Madra, Yunt, Manisa, Boz, Aydın and Mentese mountains (Fig. 2). The grabens extending in the same direction are Edremit, Bakircay, Gediz, Küçükmenderes, Büyük menderes. These grabens also include the valleys of the rivers called Bakircay, Gediz, Küçük Menderes, Büyük Menderes (Cukur 2001).

There is considerable altitudinal difference, attaining more than 1000 m between the horsts and grabens.

### 3.1. Climatic properties

The Mediterranean climatic conditions prevail in the study area. But summer period is less hotter and winter period is rather milder than that of the Mediterranean geographical region.

The mean annual temperature ranges from 18°C in the southern part to 15-16°C towards the northern parts in the coastal belt of the region and the annual average temperature drops as low as 12°C in the inland section in the Mediterranean zonobiome areas.

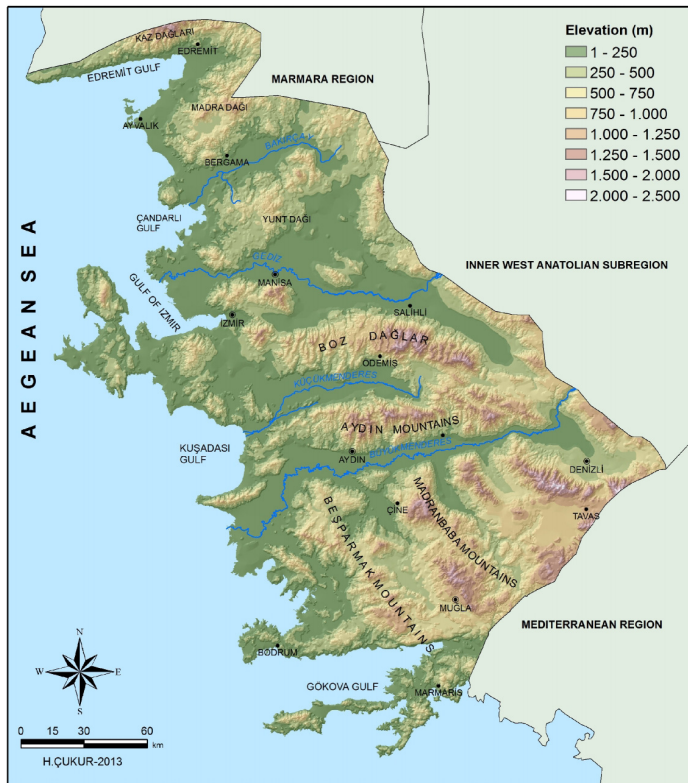


Fig. 2. The general topographic view of study area

### 3.2. Vegetation Properties

Maquis and red pine (*Pinus brutia*) communities constitute the climax vegetation of the Aegean subregion. The distribution of natural vegetation has been affected by the exposure and altitudinal conditions of the region. Towards the north, red pine occurs up to 700-800 m on the south-facing slopes, while chestnut, oak and black pine communities are widespread on the slopes facing-north. The pure red pine forests are widespread at an elevation of 400-500 m. On the other hand, the red pine clusters occurring in the inland part of the region is in poor quality, in general.

### 3.3. Potential of the Aegean Subregion

The fertile plane Edremit, Bakırçay (Bergama), Gediz, Kuçukmenderes and Buyukmenderes plains are located in the area. These are the prominent fertile agricultural lands of Turkey. Most of the fruits including some subtropical and tropical fruits and vegetables were grown in these plains.

Sandy deposits and alluvial plains lying between foothills of mountainous areas form a special habitat for fig cultivation. Most of the fig gardens occur on the gravelly and sandy soils in those areas. These areas are the most prominent habitat for the fig production due to the fact that fig roots easily develop and take required water within the gravelly and sandy soils (Atalay et al., 1993).

The vineyards are common on the sandy or alluvial soils in the grabens because the roots of grapevine penetrate deeper part of these soft materials.

The mean July temperature is about 28°C in the southern coastal belt, and it falls to 25°C in the northern part. The mean January temperature changes between 4°C and 8°C. The mean annual precipitation is 564 mm (Akhisar), 700 mm (İzmir). The half of annual precipitation falls during in winter period.

The amount of annual precipitation shows considerable variations year by year. For example, the annual precipitation of İzmir ranges from 330 mm to 1100 mm. On the other hand, in some places, the average annual precipitation is higher than the region's average.

For example the annual mean precipitation of Menteşe subregion in the south, is the most rainy part of the region with 1500 mm. In the Aegean subregion, frost days start from the second half of November and continue to the first half of March. The number of annual average yearly frost days is 6,3 in İzmir, while 36 days in Akhisar-Manisa (Çukur & Buldan, 2006; Çukur, 2007).

### 3.4. Problems of the Aegean Subregion

Misuse of land, over utilization of forests, over and early grazing are the the main problems of the study area. Most of the agricultural lands are found in land classes of VI. and VII. These land capability classes can be safe if they are used for the forest and meadow. But some sloppy land in mountainous areas and the edge of the grabens were used for agricultural practices. For that reason the steep slopes of the Boz and Aydin mountains have been converted into rocky and bare land as the result of the soil erosion. The soft deposits laying on the foothills of the mountains were dissected by deep gullies (Atalay, 1984; Çukur, 2001).

### 4. Determining of land-use types

Landsat satellite images were used to determine the land use-types of in the study area. These images are p179 r034, p180 r033, p180 r034, p181 r033, p181 r034 which include seven bands and different years 1990 and 2005.

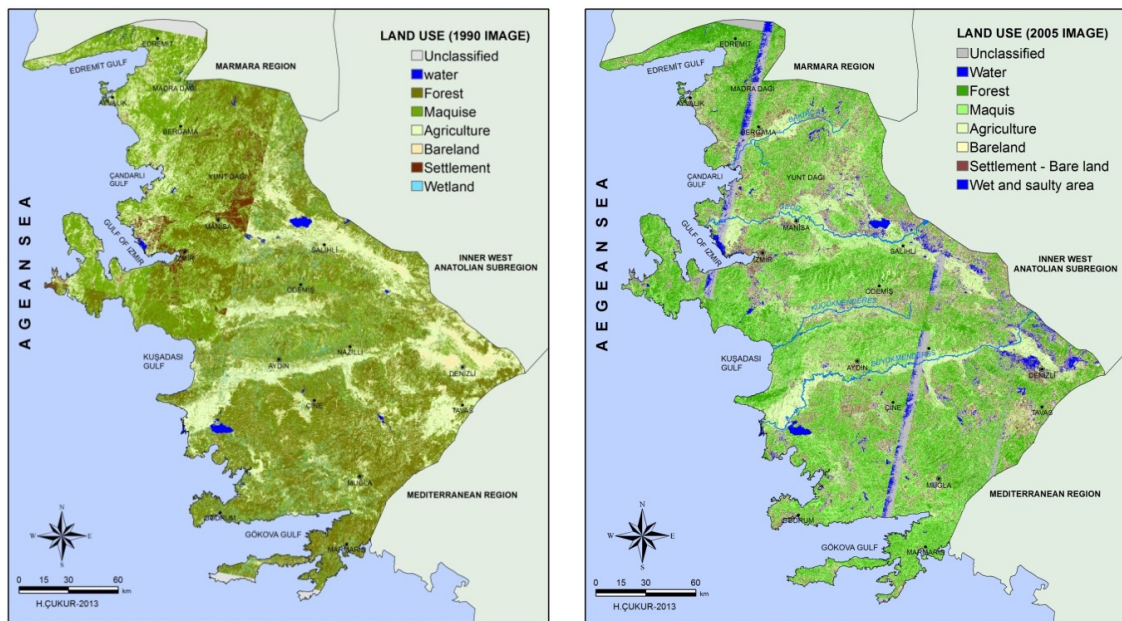


Fig. 3 - 4. In the Aegean sub-region, types of land use for the years 1990 and 2005.

Supervised and unsupervised classification analysis method were used by means of GIS and RS (ArcGIS and Erdas) software. Using 22 control points (settlement, forest, maquis, bare-land etc.) which were collected from the study area, another signature file was created. This signature file has been compared with unsupervised classification file for to check of results. 50 different class types determined by means of unsupervised classification in the first step. And second step “recode method” is used in order to decrease land use types from 50 to 9 class. After that the differences between 1990 and 2005 land-use classes were determined and interpreted.

### 5. Land-use types in the Aegean Subregion

Land use types in the study area are agricultural land, settlement area, bare land, forest, maquis, water, wet/salty area and unclassified area.

In the Aegean Sub-region, land-use type maps were generated separately for 1990 and 2005 years (Fig. 3, 4). Usually an increase in settlement and agricultural areas on a map of 2005 were observed, but there is a decrease in forest lands. Table 1 demonstrates the type of land-use changes in 1990 and 2005.

Land use types and landuse change were shown in table 1 and figure 5. The most significant decrease in forest lands occurred during the period between 1990 and 2005. The forest lands decreased, other classes increased in 2005.

Table 1. Landuse change from 1990 to 2005 in the Aegean Subregion.

Land-use Classifications	1990		2005		Percentage of Change
	km <sup>2</sup>	%	km <sup>2</sup>	%	
Unclassified	418.82	0.10	132.26	0.03	0.07
Water	330.10	0.76	346.26	0.80	0.04
Forest	18765.39	43.44	12017.36	27.82	-15.62
Maquis	12552.72	29.06	13688.32	31.69	2.63
Agriculture	4451.41	10.30	5916.80	13.70	3.39
Bare land	3324.98	7.70	4783.72	11.07	3.38
Settlement	2034.40	4.71	4842.08	11.21	6.50
Wetland	1320.18	3.06	1471.26	3.41	0.35
Totally	43198.00	100.00	43198.05	100.00	0.00

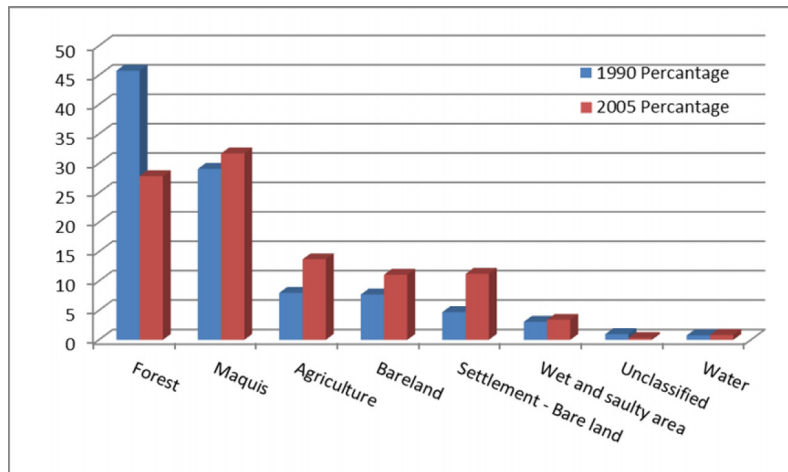


Fig. 5. Change of land-use class from 1990 to 2005

In general, the forest areas have been changed into shrublands. And then these maquis (shrub) communities have been converted into agricultural areas, settlement or bare lands. Improper land use practices and land degradation increased in the study area (Çukur & Gunduzoglu, 2008).

As shown in the figure 6, rapidly growing settlement areas around the bay of Izmir is remarkable from 1990 until 2005. Similar situation is observed in Manisa, Aydin and Denizli.

These emerged following results.

- Due to the suitable environmental conditions, people migrate to the Aegean Subregion.
- There is a need larger areas for settlement due to migration.



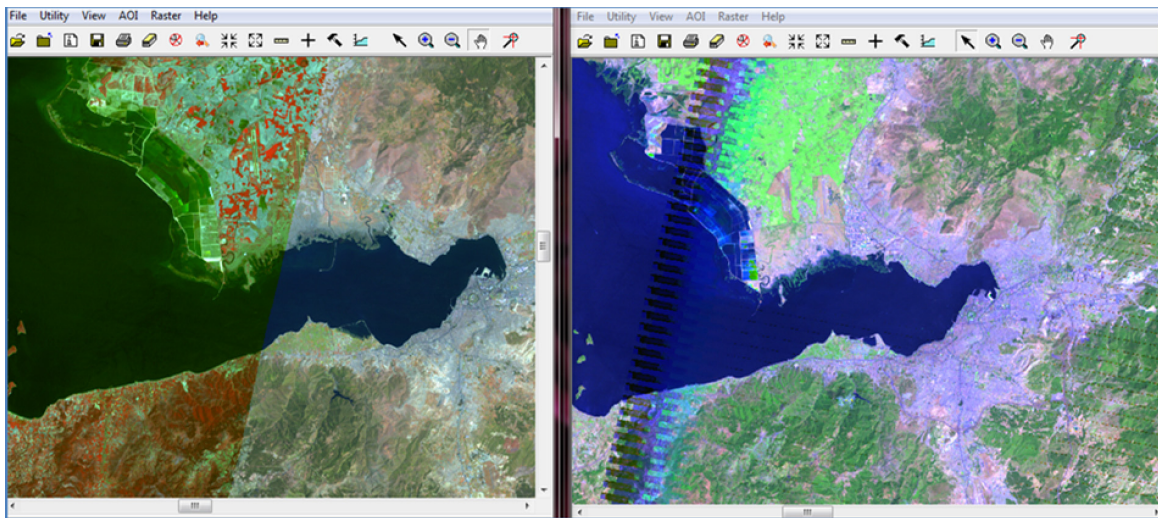


Fig. 6. The changing of settlement areas from 1990 to 2005 around the gulf of Izmir (left 1990, right 2005).

- Land needer for industrial activities.
- Settlement areas and industrial activities have developed on the agricultural lands.
- Agricultural activities developed on forested and sloping areas.
- Due to the agricultural activities and animal husbandry in the forest land located in rugged area have been changed into scrublands.
- After a period, maquis or bush lands turn into bare lands due to erosion.

Table 2. Distribution of 2-B lands (lost forest property), in term of altitude and slope conditions in the Aegean Sub-region (Aegean Forestry Research Institute 2006).

Properties	Statistical	Land-use Types			
	Value	Olive	Orchard	Cropland	Vineyards
Slope (%)	Average	33.17	48.13	41.86	36.86
	Min.	15.84	15.84	14.05	21.26
	Max.	53.17	90.04	64.94	50.95
	Average	297.39	515.58	474.00	631.67
Altitude (%)	Min.	150.00	240.00	180.00	440.00
	Max.	630.00	890.00	900.00	785.00

As a result of the actual situation, 2B (degraded forestlands) Law passed in the parliament. According to this law, the peasants were allowed to use degraded forestlands for agriculture and animal husbandry. This development reduced the size forest areas. For example the size of degraded forest lands 29.138 ha in Muğla, 34.887 ha in Balıkesir and 14.772 ha Izmir. Therefore, the forest areas declined to 17%, based on 2005 data (Bilgin, 2006). High and sloping terrain have been used for olives, viticulture, orchards and agricultural purposes (Table 2).

## 6. Examples of improper land use in the study area



Fig.7 - 8. After forest fire in the red pine forest near Izmir (left); forest fire on the shrub land near Cesme-Izmir (right).



Fig. 9 - 10. After the forest fire bare land appeared on the steep slope near Buldan-Denizli (left) agricultural activities in the forest land near Buldan-Denizli (right). Altitude is more than 1200 m.



Fig.11 - 12. Agricultural activities in the forest land near Sarıgöl-Manisa (left). Olive groves near the forest land around Mugla (right).





Fig. 13 - 14. Animal husbandry activities on the maquis communities in the study area (left), and grazing cones were formed due to these activities, on the shrub lands (right).



Fig.15 - 16. Growing settlement area on the agricultural land (Bayındır, left). Agricultural activities on the steep slopes northern part of Boz mountains (right).



Fig.17 - 18. The settlement area on the steep slope around southern part of Izmir Gulf (left). Settlement areas on northern part of gulf of Izmir (right).

## 7. Conclusions

Changing situation in the area between 1990-2055;

- Forest lands decreased by 17%
- Maquis communities increased by 2,63%



- Agricultural areas increased by 5,71%
- Bare lands increased due to erosion by 3,40%
- Settlement areas increased by 6,50%
- There is risk on the forest land in the area.
- The decrease in the forest and total increasing in the maquis, settlements and bare lands are almost equal.
- The forest lands were converted to maquis communities,
- The maquis area was converted to agricultural land,
- The farmlands were converted to settlement areas.

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